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Science Bowl Questions: Assorted Round 7

1. Toss-up: Chemistry: Multiple Choice: In the reaction between beryllium atoms and chlorine atoms in the presence of oxygen gas, which of the following is true?

W. The Beryllium atoms become cations

X. The Beryllium atoms become anions

Y. The chlorine atoms become oxidized into polyatomic ions

Z. The Beryllium atoms and Chlorine atoms share electrons

ANSWER: Z

Bonus: Chemistry: Short Answer: When stable element in the alkali metals is the strongest reducing agent in gaseous form?

ANSWER: Cs

1. Toss-up: Chemistry: Short Answer: In the reaction between selenous acid and the Iodide ion in acidic solution to form the triiodide ion, water, and precipitated selenium, what element(s) are reduced and what are oxidized, respectively?

ANSWER: Selenium is reduced, Iodine is oxidized

Bonus: Chemistry: Multiple Choice: The reaction 2A + B → C has the following proposed mechanism.

Step 1: A + B → D Step 2: D + B → E Step 3: E + A → C + B

If Step 2 is the slowest step of the mechanism, what is the rate of formation of C, in terms of A, B, and k?

W. k[A]

X. k[A]2[B]

Y. k[A][B]2

Z. k[A][B]

ANSWER: Y

1. Toss-up: Chemistry: Multiple Choice: In the compound ethanoic acid, we wish to find three bond angles. Which one of the following could not possibly be a bond angle between any three atoms in ethanoic acid?

W. 104.5°

X. 109.5°

Y.180°

Z. 120°

ANSWER: Y

Bonus: Chemistry: If diatomic chlorine gas is mixed into cold water, what two acids are formed?

ANSWER: Hypochlorous acid, Hydrochloric Acid

1. Toss-up: Chemistry: Multiple Choice: Which of the following is true about the Ostwald Process?

W. Nitrogen Gas reacts with Oxygen Gas at 900 °C with the presence of a catalyst to form nitric oxide

X. Nitric oxide is oxidized to nitrogen dioxide at 25 °C

Y. Nitrogen dioxide is absorbed into water to form nitric acid and nitrogen gas

Z. The process automatically produces a 68% nitric acid azeotrope

ANSWER: X

Bonus: Chemistry: Multiple Choice: The molal freezing point depression constants for benzene and water are 5.12 and 1.86 respectively. If equal amounts of formic acid are added to both 1.0 kg of benzene and 1.0 kg of water, then the freezing point depression of the water solution is 75% of that of the benzene solution. To explain this, we assume that:

W. formic acid is associated in benzene and monomeric in water

X. formic acid is monomeric in benzene and dissociated in water

Y. formic acid is monomeric in benzene and associated in water

Z. formic acid is dissociated in benzene and monomeric in water.

ANSWER: W

1. Toss-up: Physics: Short Answer: Chip stretches a rubber band. He realizes that up to a certain limit, the force of the rubber band pulling back is proportional to its displacement. He continues to stretch it, and finds that it is permanently deformed if he stretches it past the second limit. After a third and final stretch, Chip breaks the rubber band. Name the three limits in the order that Chip encountered them, respectively.

ANSWER: Proportional limit, elastic limit, breaking point

Bonus: Physics: Multiple Choice: Substance X has a bulk modulus of 1011. If a pressure of 1000 bars acts on a cube of substance X that has a side length of 1m, what is decrease in volume of the cube of substance X?

W. 10-9 m3

X. 10-6 m3

Y. 10-3 m3

Z. 10-1 m3

AMSWER: Y

1. Toss-up: Physics: Multiple Choice: Which of the following is not true?

W. A conductor at electrostatic equilibrium has no internal electric field

X. The resistance of a circuit composed of resistors in parallel of 10 and 20 ohms is 20/3 ohm

Y. A dielectric increases capacitance and lowers voltage across a capacitor

Z. A capacitor is the slowest at draining charge compared to a battery

ANSWER: Z

Bonus: Physics: Short Answer: If a football player throws a football at a thirty degree angle to the horizontal at 20 m/s, what is the maximum vertical height of the football? g=10 m/s2

ANSWER: 5 m

1. Toss-up: Physics: Multiple Choice: In addition to the high temperature requirements of a fusion reaction, the plasma ion density and the plasma confinement time in the reactor must be above a critical value to ensure that the process produces more energy than is necessary to heat the plasma. What theory quantifies this critical value?

W. Tokamak Theory

X. Proton Proton cycle

Y. Cross-sectional criterion

Z. Lawson criterion

ANSWER: Z

Bonus: Physics: Short Answer: Electroweak symmetry is said to be broken through our current understanding of particle physics, because the photon has no mass, whereas W and Z bosons do. At high temperatures, the electromagnetic and weak forces fuse because these masses become insignificant fractions of their total energy. What hypothetical particle provides a mechanism for breaking this symmetry?

ANSWER: Higgs Boson

1. Toss-up: Physics: Multiple Choice: Which of the following periods of time, after the universe, saw the decay of the electroweak force into the electromagnetic and weak force?

W. 10-35 s

X. 10-20 s

Y. 10-15 s

Z. 10-10 s

ANSWER: Z

Bonus: Physics: Multiple Choice: Which of the four fundamental forces has the shortest range of about 1.0 × 10-3 fm?

W. Strong

X. Weak

Y. Electomagnetic

Z. Gravity

ANSWER: X

1. Toss-up: Biology: Multiple Choice: In the Calvin-Benson cycle, electrons from P700 are transferred to the Primary Acceptor in Photosystem I. What is the name of the enzyme that then transfers these electrons, beginning the electron transport chain, which eventually create NADPH?

W. Ferredoxin

X. NADP+ reductase

Y. Plastoquinone

Z. Cytochrome complex

ANSWER: W

Bonus: Biology: Short Answer: In certain cases, photoexcited electrons can take an alternative path, which uses photosystem I but not photosystem II. The electrons in this path move from ferredoxin to the cytochrome complex, producing ATP but not NADPH. What is this process?

ANSWER: Cyclic Electron Flow

1. Toss-up: Biology: Multiple Choice: In many cases of colon cancer, proto-oncogenes are mutated, changed, or lost in some way that causes cancer. Which of the following genes is a proto-oncogene that could cause cancer or lead up to causing cancer by preventing any end to that cell’s division?

W. telomerase

X. APC

Y. DCC

Z. BRAC1

ANSWER: W

Bonus: Biology: Short Answer: What is the name for maternal substances in the egg that influence the course of early development after fertilization? After mitotic divisions of the zygote, these factors may be distributed separately into separate cells, causing different epigenetic changes.

ANSWER: Cytoplasmic determinants

1. Toss-up: Biology: Short Answer: What is the name for radial files of cells that connect the secondary xylem with the secondary phloem? These cells move water and nutrients between the secondary xylem and phloem, store carbohydrates, and aid in wound repair.

ANSWER: Vascular Ray

Bonus: Biology: Multiple Choice: Currently, golden-colored rice, a genetically modified type, is being implemented around the world in poverty-stricken areas of the globe to treat what vitamin deficiency?

W. Vitamin A

X. Vitamin C

Y. Vitamin B3

Z. Vitamin B12

ANSWER: W

1. Toss-up: Biology: Multiple Choice: What is the name of the nontropic hormone that regulates the activity of pigment-containing cells in the skin of some amphibians, and appears to act on neurons in the brain inhibiting hunger in mammals?

W. thyrotropin-releasing hormone

X. prolactin

Y. adrenocorticotropic hormone

Z. melanocyte-stimulating hormone

ANSWER: Z

Bonus: Biology: Short Answer: Pathogens that make their way into the body are subject to detection by phagocytic white blood cells called leukocytes. These cells recognize microbes using receptors that recognize fragments of molecules characteristic of a set of pathogens. What are these receptors called?

ANSWER: TLR (Toll-Like Receptor)

1. Toss-up: Math: Multiple Choice: If the function F(x) is defined as , then what is the equation of the tangent line to function F(x) at (e,1)?

W. y = -ex -1

X. y = ex - e

Y. y = ex – e +1

Z. y= -ex – e +1

ANSWER: Y

Bonus: Math: Short Answer: Find the function F(x) described in the above tossup question. F(x) = .

ANSWER: (x)(lnx)-x +1

1. Toss-up: Math: Short Answer: If Set A has the numbers {1,2,3,4} and Set B has the numbers {4,5,6,7}, state the complement of Set A relative to Set B and the systematic difference of Sets A and B.

ANSWER: Complement of Set A relative to Set B: {5,6,7} Systematic Difference: {1,2,3,5,6,7}

Bonus: Math: Short Answer: Taking the same sets above, where Set A is {1,2,3,4} and Set B is {4,5,6,7}, what is the powerset of the set that is the complement of Set B relative to Set A?

ANSWER: {{},{1},{2},{3},{1,2},{2,3},{1,3},{1,2,3}}

1. Toss-up: Math: Multiple Choice: Of the following choices, which one is the correct formula for finding a tangent line to a hyperbola which has its center at the origin given the point (x,y) where the tangent line passes through the hyperbola?

W. x/y

X. –x/y

Y. y/x

Z. –y/x

ANSWER: W

Bonus: Math: Short Answer: Find the volume of the region represented by the integral rotated around the x-axis.

ANSWER: 8π

1. Toss-up: Math: Multiple Choice: Approximate the cosine(0.2) as a decimal to the hundredth place, using the second maclaurin polynomial for cos(x).

W. 1.00

X. 0.99

Y. 0.98

Z. 0.90

ANSWER: Y

Bonus: Math: Short Answer: Sara is 3 times younger than her sister. If her sister dies three years later, assuming that her sister’s age remains constant after death, if Sara will be twice as old as her sister in 31 years, what is the age of her sister’s death?

ANSWER: 18

1. Toss-up: ERSC: Multiple Choice: Which of the following represents the largest reservoir of freshwater that is readily available to humans?

W. Lakes and Reservoirs

X. Water Vapor in the Atmosphere

Y. River Water

Z. Groundwater

ANSWER: Z

Bonus: ERSC: Short Answer: What method of artificial flood control involves altering a stream channel in order to speed the flow of water to prevent it from reacting flood height by clearing a channel of obstructions or dredging a channel to make it wider and deeper?

ANSWER: Channelization

1. Toss-up: ERSC: Multiple Choice: As water percolates downward through the E horizon, finer particles are carried away. What name is given to the washing out of the fine soil components in the E horizon?

W. leaching

X. solum

Y. enrichment

Z. eluviations

ANSWER: Z

Bonus: ERSC: Short Answer: What two features form when the downstream meander of a stream encounters rock resistant to erosion and the upstream meander catches up to it?

ANSWER: Cutoff and Oxbow lake

1. Toss-up: ERSC: Short Answer: The turbidites deposited of silt and clay on the ocean floor are characterized by a decrease in sediment grain size from bottom to top. What is this phenomenon in the ocean, similar to sorting in rivers and streams, called?

ANSWER: Graded bedding

Bonus: ERSC: Multiple Choice: What type of seafloor sediment is characterized primarily by minerals that crystallize directly from seawater as they become insoluble? These include manganese nodules, calcium carbonates, metal sulfides, and evaporites.

W. Terrigenous Sediment

X. Biogenous Sediment

Y. Hydrogenous Sediment

Z. Hydrates

ANSWER: Y

1. Toss-up: Astro: Multiple Choice: What type of spectroscopy is a useful application of scattering spectroscopy?

W. Auger Spectroscopy

X. Raman Spectroscopy

Y. Flame Emission Spectroscopy

Z. Laser Induced Breakdown Spectroscopy

ANSWER: X

Bonus: Astro: Short Answer: What kind of astronomy, dependent upon a light source in the electromagnetic spectrum, can see through the galactic center with less detail than our visible telescopes, and has consistently been used to image the galactic center?

ANSWER: ACCEPT Infrared and Radio

1. Toss-up: Multiple Choice: Which of the following is the most precise location of our solar system in the Milky Way?

W. On the Perseus Arm

X. On the Sagittarius Arm

Y. On the Orion minor Arm

Z. On the Norma Arm

ANSWER: Y

Bonus: Astro: Short Answer: What is the name of the local group of stars which include our Sun, Beta Canis Majoris, and Antares, but not Betelgeuse?

ANSWER: Local Bubble

1. Toss-up: Astro: Short Answer: This pressure pushing outward in a white dwarf smaller than the Chandrasekhar limit will be able to balance the inward gravitational pressure.

ANSWER: Electron degeneracy

Bonus: Astro: Short Answer: What two principles of quantum physics predict the electron degeneracy pressure?

ANSWER: Heisenberg uncertainty principle and Pauli exclusion principle